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Effects of different antibiotic residues in manure on soil greenhouse gas emissions and plant available nitrogen

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Veterinary antibiotics are commonly used in animal husbandry to treat bacterial infections. As antibiotics are not fully adsorbed within the animals, large amounts of antibiotics are present in animal manure. Circular agriculture aims to close elemental cycles which increases reliance on animal manure. The application of manure with antibiotic residues may impact the soil microbial functions essential for nutrient cycling and climate regulation. It is yet not clear how different types of antibiotic residues in manure affect the soil greenhouse gas emissions and plant available nitrogen (N). Whether the impacts of antibiotics are correlated to their persistence or sorption in soil also deserves investigation. An incubation experiment was designed to fill the research gaps, especially with respect to antibiotic residue impacts on soil carbon dioxide (CO2) and nitrous oxide (N2O) emissions and plant available N- ammonium (NH4+) and nitrate (NO3-) in soil. Cattle manure was spiked with four different antibiotics (flumequine, oxytetracycline, sulfadiazine, tylosin). The spiked manure was mixed with sandy grassland soil and incubated at 17 °C for 31 days in PVC columns. A treatment with manure without antibiotics and a treatment with only soil were also included. Fluxes of CO2 and N2O from the soil columns were measured 20 times in 31 days. Soil NH4+ and NO3- were analyzed on the 12th and the 31st day. To test the availability of the antibiotics in soil over time, we evaluated the dissipation and sorption of antibiotics in soil by conducting extraction with both acetone-nitrile and 0.001M calcium chloride (CaCl2) solution. The application of manure spiked with oxytetracycline, and sulfadiazine significantly reduced the cumulative N2O emissions, compared to that of manure without antibiotics. Moreover, the manure spiked with oxytetracycline increased cumulative CO2 emission. We did not find a significant effect of the different antibiotics on soil NO3- and NH4+ availability. Although sulfadiazine had the fastest degradation rate in soil among four antibiotics, it exerted a strong inhibition on soil N2O emissions. Soil mineral N availability and greenhouse gas emissions were not significantly influenced by neither the most persistent antibiotic- flumequine nor the most water-soluble antibiotic- tylosin. Our results suggested that the application of manure with antibiotic residues may affect the soil greenhouse gas emissions. No clear correlation between the persistence and sorption of antibiotics in soil and the magnitude of these impacts could be detected.

Keywords: